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Improving Patient Safety in Dentistry: A Systematic Review of Adverse Event Contributors

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Abstract **Background:** Adverse events in dental practice are a threat to patient's safety and hold practitioners accountable. **Objective:** This systematic review pinpoints and examines the factors causing adverse events in the dental setting. **Methods:** The Researcher ran a systematic search through Web of Science and Scopus databases, by focusing on studies from January 2010 up to January 2023. 20 studies were included and were evaluated with the Newcastle-Ottawa Scale. **Results:** Typical adverse events covered endodontic errors, along with pain, nausea and problems during procedures. The major factors playing a role included; the dentist's level of experience, complexity of the procedures, patient's reactions to medications and conditions unique to each patient. Notably, 70% of perforations are correlated to mistakes made by dental trainees. **Conclusion:** The majority of these dental adverse events could be avoided and are preventable with better training, setting protocols and improved communication. These results point toward creating focused interventions to boost patient safety overall. **Clinical Relevance:** This review points out practical steps for decreasing adverse events in the dental practice, by stressing on the importance of strict infection control, ongoing education for practitioners and updating policies.

Key Words Dental Adverse Events, Sentinel Events, Patient Safety, Healthcare Quality, Dental Clinic, Systematic Review

INTRODUCTION

Errors are an inevitable by-product of any service. Accordingly, all healthcare services have the potential to result in harm [1,2]. Adverse events (AEs) in dental practice can have detrimental effects on both patients and practitioners; these include physical pain, psychological distress and financial burden, as well as damage to the reputation of dental professionals [3]. Additionally, AEs can lead to legal liability and the potential loss of the dental practitioner's license [4].

The cost associated with AEs in healthcare, including dentistry, is substantial and necessitates more efficient resource utilization and preventive strategies [5,6].

In 2000, the Institute of Medicine (IOM) published "To Err is Human: Building a Safer Health System," which estimating that 44 000 to 98 000 Americans die each year from medical mistakes. This monumental report was eye-opening in regard to patient safety and it set the stage to improve healthcare quality [7].

In a dental setting, AEs cause harm or injury leading to morbidity and can also lead to mortality [8]. AEs are classified into two categories: preventable and non-preventable occurrences. Non-preventable dental AEs rendered by the dental clinician can be attributed to patient factors, where both the caregiver and the patient are unaware of a relevant patient condition [9]. An example is patient side effects caused by sensitivity to specific dental biomaterials, such as the chrome and cobalt in a fixed dental prosthesis [10].

Preventable AEs can occur due to mismanagement and improper planning by the dental practitioner. These are also known as errors of omission (i.e., not performing the task). This may happen when the dentist fails to take the patient's medical history or miscommunicates with other members of the medical team, resulting in AEs that would not have occurred if managed and planned properly [11].

Examples of preventable AEs include instances where the dental practitioner fails to collect the patient's medication allergies but proceeds to prescribe medication. Alternatively, the practitioner might neglect to verify the patient's comorbidities [12]. Preventable AEs can also occur due to errors of commission, where the dentist makes an error of planning, such as prescribing the wrong medication or an error of execution after proper planning, such as prescribing an improper dose. Another example is inadvertently nicking and damaging a neighbouring tooth while operating on an adjacent tooth [13].

Although it is rare, an AE can lead to mortality, permanent harm or severe temporary harm, including psychological harm; this is referred to as a "sentinel event" [14]. Examples of sentinel events in dental practice are extraction of the wrong-side tooth or operating on the wrong tooth. These errors can ultimately cause patient depression due to the loss of a vital tooth [15]. Another example is the ingestion of parts of a fractured tooth during an extraction, which can lead to severe consequences [16]. Aspiration of a dental crown while in the clinic is also a potential sentinel event [17].

Another additional example of a sentinel event in the dental clinic would be operating on a patient with cardiovascular disease without consulting the patient's cardiologist to adjust blood coagulation and measure INR (international normalized ratio) levels prior to an invasive dental procedure [18]. This oversight could lead to haemorrhage, ischemia, and/or death [19]. Deaths attributed to dental anaesthesia are also categorized as sentinel events. The mortality ratio has been estimated at 1 death for every 327 000 cases [20].

According to Pérez *et al.*, in a study conducted in Spain, dental specialties with the highest frequency of AE cases were implantology, endodontics and oral surgery [21]. Brennan *et al.* added that AEs occurred at a rate of 3.7% (95% CI, 3.2-4.2) of all inpatient hospitalizations, of which 70% and 2.3% caused temporary and permanent impairments, respectively [22].

The cost of AEs is extremely high, especially considering the scarcity of resources in healthcare. In a 2009 study performed by Hoonhout *et al.*, preventable AEs in Dutch hospitals comprised 2.3% and 3% of all admissions and bed days, respectively. The estimated cost of all AEs in these hospitals was over $385 million, with 45% attributed to preventable AEs, amounting to over 1% of the national health budget [5]. Goodman *et al.*, as of 2006, estimated the social cost of AEs in healthcare to be between 400 and 950 billion USD, which is equivalent to 18% to 45% of the total US healthcare expenditure [6].

Limited information exists regarding AEs in dental practice and few published studies delve into how dental providers articulate these occurrences [8]. AEs in the dental setting can be attributed to a plethora of reasons and may be due to human factors and behaviours of the patient and/or the provider, as well as a lack of standardization compared to other medical specialties [23].

Methods such as leadership intervention, proper communication, teamwork along the continuum of care, effective policy making and standardization reduce the chances of AEs. Additionally, proper specialized training, supervision and monitoring contribute to patient safety [24].

Many studies have shown that failure to adhere to proper infection control measures can lead to AEs in dental practice. This includes inadequate sterilization of instruments, improper disposal of waste and lack of proper hand hygiene [25].

Objectives

This systematic review aims to spot and sort out the different types of AEs that occur in the dental practice. It also looks at the root causes behind these issues. AEs including errors from practitioners, complexity of procedures and conditions unique to patients. Furthermore, the review seeks to evaluate severity of AEs accompanied by implications for patient safety, by synthesizing them from the literature. The findings provide suggestions to improve everyday clinical practices, improve training methods and shape policies that could prevent AEs in the dental setting.

How this Study might Affect Research, Practice or Policy?

Identifying the factors contributing to AEs provides a foundation for developing targeted interventions to improve patient safety. The emphasis on communication, standardization and infection control measures affirms best practices and guidelines for dental practitioners. Additionally, the study's findings highlight the need for ongoing education and training for dental professionals to prevent them from happening. Policymakers can use this information to implement regulations and standards that promote patient safety and reduce the incidence of AEs in the dental practice.

METHODS

Study Design

This study was reported according to the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA). PRISMA extensions were also used to prepare for the review [26].

Identification and Selection of Studies

Search Strategy: The researcher carried out a systematic literature search using the Web of Science and Scopus databases. This helped identify studies on AEs in the dental practice. The search covered articles published from January 2010 to January 2023. Keywords included "adverse events," "patient safety," "dentistry," "dental errors," and "risk factors." These phrases were combined with Boolean operators to narrow down the results. The application included filters for clinical trials and observational studies with human subjects. Furthermore, the search excluded reviews, editorials and non-English publications.

Selection Criteria

Studies qualified for inclusion were if they covered AEs in dental settings, pointed out contributing factors and appeared in English during the set time frame. The focus was only on original research articles. The search excluded reviews, meta-analyses, case reports, letters, editorials and publications on procedures outside dental care or non-human subjects, additionally leaving out studies without full-text access.

Data Selection and Extraction

The researcher removed duplicate records before starting the screening process. Two researchers independently checked the titles and abstracts of the leftover articles for relevance. Next, the researchers reviewed full texts against the inclusion

Table 1: Study characteristics

Author	Study type	Sample size	Study aims	Outcome measure	Reported adverse events	Factors contributing to the adverse events	Findings
Alamoudi *et al.* [43]	Retrospective cross-sectional study	1000	To assess iatrogenic complications after the use of the case difficulty assessment form.	Occurrence of adverse events	Ledge, apical, lateral root, strip, furcation and coronal-cervical perforation.	Underfilling, overfilling and fractured instruments.	Following the recommendations of the American Association of Endodontists will minimize the risk of iatrogenic errors.
Alghamdi *et al.* [32]	Observational study	404	To evaluate the incidences and nature of endodontic mishaps in root canal-treated teeth done by undergraduate dental students.	Occurrence of endodontic mishaps	Endodontic mishaps	Access opening and instrumentation.	Endodontic mishaps were related to root canal obturation.
Brain *et al.* [33]	Double-blind, randomized controlled trial.	316	To compare the new creation's effectiveness and beginning of analgesia with standard ibuprofen tablets.	Pain relief and pain intensity	Nausea, vomiting, chest discomfort, dyspnoea, nausea and vomiting.	Drug-related	The novel ibuprofen provided better pain relief than the standard ibuprofen tablets.
Brennan *et al.* [34]	Phase 2 randomized clinical trial	138	To assess the effectiveness and safety of a novel mucoadhesive clobetasol patch for treating oral lichen planus.	Change in the total ulcer area, pain improvement, disease activity and quality of life.	Periodontal disease and nasopharyngitis.	Clobetasol or the patch in the treatment.	The novel clobetasol patches were superior, with a considerable safety profile.
Brunton *et al.* [35]	Clinical safety study	15	To assess the safety and effectiveness of biomimetic self-assembling peptide for class V white spot lesions.	Occurrence of adverse events and lesion appearances	Chest infection, dental hypersensitivity, a sprained joint between spine and pelvis, stomach upset, sensitivity with a Corsodyl mouth rinse, diarrhoea and vomiting and superficial staining.	Treatment procedure.	Early caries lesions treatment using biomimetic self-assembling peptides is safe.
Ciancio *et al.* [39]	Phase 3 clinical trial	110	To compare the safety and efficacy of nasal spray combination and tetracaine-only spray with a placebo spray.	Occurrence of adverse events	Rhinorrhoea, nasal congestion, nasal discomfort, oropharyngeal pain, hypoesthesia, throat irritation, paraesthesia, bradycardia, hypertension, rhinalgia, upper-airway cough syndrome, tachycardia, toothache, dysgeusia, sinus headache.	Drug used	The nasal spray combination was safe and more effective for pulpal anaesthesia of maxillary teeth.
Davidovich *et al.* [36]	Retrospective study	32	To assess the short-term post-sedation outcomes after dental treatment.	Occurrence of post-sedation complication	Sleepiness, restlessness, oral cavity pain, appetite loss, nausea, vomiting, incontinence, fever and insomnia.	Anaesthetic used	Deep sedation poses complications and adverse events
de Carvalho and do Egito Vasconcelos [40]	Prospective cohort study	140	To evaluate the occurrence of adverse events during the removal of affected lower third molars in overweight subjects.	Occurrence of adverse events	Crown and root fracture, inadvertent perforation tissues, flap laceration and bleeding.	Incorrect tooth sectioning and obesity.	Overweight patients are highly likely to experience morbidities.
de Carvalho and do Egito Vasconcelos	Prospective randomized study	280	To evaluate the occurrence of adverse events in impacted third molar surgery.	Occurrence of adverse events	Pericoronitis and dental ankylosis.	Being overweight	Being overweight is a risk factor for adverse events in impacted third molar surgery.
Hiivala *et al.* [38]	Retrospective study	1041	To evaluate incidences and causes of adverse events in Finnish dental care.	Patient safety parameters and incidences of adverse events	Allergic reactions, haemorrhage, damage to adjacent teeth and sensory impairment.	Damage to surrounding tissues, anaesthesia used and medication-related	Severe dental AEs are relatively rare.
Hughes *et al.* (2012)	Retrospective study	287	To assess the occurrence of adverse events in a dental teaching hospital.	Volume, rate, nature, management and outcome of adverse incidents	Unspecified	Instrumentation and equipment.	Adverse events are part of dental practice.
Maramaldi *et al.* [8]	Prospective study	76	To develop an adverse events inventory.	Occurrence and causes of adverse events	death due to cardiac arrest, jaw fatigue, allergic reactions, infection, bleeding, pain, hard-tissue damage, soft- injury, nerve injury and other systemic complications.	Lengthy procedures and quality of care.	There was an extensive, diverse list of adverse events.

Table 1: Study characteristics

Author	Study type	Sample size	Study aims	Outcome measure	Reported adverse events	Factors contributing to the adverse events	Findings
Mettes *et al.* [41]	Observational study	1000	To assess patient safety incidents in primary oral health care.	Occurrence of adverse events	Perforation, swallowing tooth fragments, periodontal leakages.	Treatment procedure and instrumentation.	Primary oral care is safe due to low adverse events occurrence.
Mustafa *et al.* [42]	Prospective study	250	To assess the causes of failure of endodontic treatment.	Causes of endodontic failure	Endodontic failure	Poor quality adjunctive treatment and inadequate filling of the root canals.	First molars were most commonly affected by an endodontic failure.
Ozkan and Akbas [46]	Retrospective study	80	To compare the hemodynamic responses and adverse events using a fibreoptic bronchoscope (FOB) and a direct laryngoscope (DLS).	Hemodynamic responses and adverse event	Nose bleeding, bradycardia, laryngospasm, hypoxia, hoarseness and throat ache.	The method of nasotracheal intubation	FOB is safer than DLS for nasotracheal intubation.
Perea-Pérez *et al.* [4]	Retrospective study	415	To investigate the nature of adverse events in dental care.	Occurrence of adverse events	Swallowing dental instruments or materials, inhalation of dental instruments or materials, prescription of drugs and neuropathic pain.	Instrumentation and prescription drugs.	Foreseeable and avoidable errors and complications caused adverse events.
Pousette-Lundgren *et al.* [28]	Randomized controlled trial	27	To compare the quality and longevity of two crown types.	Occurrence of adverse events	Apical periodontitis	Dental trauma	Crown therapy can be done without severe complications.
Thiruvenkatachari *et al.* [29]	Randomized controlled trial	64	To compare the effectiveness of twin block and Dynamax in correcting class II malocclusion.	Occurrence of adverse events.	Breakages	Type of appliance used.	The twin block was more effective.
Wu *et al.* [44]	Cross-sectional study	366	To assess the patient-reported outcome measures of dental implant surgeries and analyse the associated indicators.	Discomfort, pain and anxiety during surgery and post-surgical complications.	Pain, anxiety, swelling	Age, sex, smoking, alcohol consumption, history of periodontitis, pain and anxiety during surgery and type and extent of surgical procedure.	Alcohol consumption, pain during surgery and age led to discomfort after dental implant surgery.
Zouaidi *et al.* [45]	Observational Retrospective Study	690	To identify sedation-related adverse events.	Incidences of adverse events.	Emesis, respiratory and cardiovascular adverse events and agitation.	Paediatric dental sedation	Potentially serious AEs were identified during Paediatric dental sedations, but incidence was low.

Table 2: Results of Newcastle-Ottawa Scale quality assessment of the included studies.

Author	Selection (Maximum one star)	Comparability (Maximum two stars)	Outcome (Maximum one star)
Alamoudi *et al.* [43]	*	**	*
Alghamdi *et al.* [32]	*	**	*
Brain *et al.* [33]	*	**	*
Brennan *et al.* [34]	*	**	*
Brunton *et al.* [35]	*	**	*
Ciancio *et al.* [39]	*	**	*
Davidovich *et al.* [36]	*	**	*
de Carvalho and do Egito Vasconcelos [40]	*	**	*
de Carvalho and do Egito Vasconcelos	*	**	*
Hiivala *et al.* [38]	*	**	*
Hughes *et al.* [27]	*	**	*
Maramaldi *et al.* [8]	*	**	*
Mettes *et al.* [41]	*	**	*
Mustafa *et al.* [42]	*	**	*
Ozkan and Akbas [46]	*	**	*
Perea-Pérez *et al.* [4]	*	**	*
Pousette *et al.* [28]	*	**	*
Thiruvenkatachari *et al.* [29]	*	**	*
Wu *et al.* [44]	*	**	*
Zouaidi *et al.* [45]	*	**	*

criteria. Disagreements among reviewers got settled through discussion until consensus was reached. To keep things cantered on dental outcomes, the studies that failed to report contributing factors clearly or mixed in unrelated procedures were excluded.

Methodological Quality Assessment

The researcher evaluated the methodological quality of included studies with the Newcastle-Ottawa Scale. This scale looks at three main areas. It covers selection of study groups, comparability between groups and how outcomes were determined. Each study received a score in these areas. Then, they were grouped as high, moderate or low quality based on the overall total. Finally, this step confirmed the reliability and validity of the key findings from the review. The criteria used were participant selection, comparability and study outcomes, as shown in Table 2 [30].

Data Synthesis

The researcher extracted data from the included studies and tabulated it using a pre-designed template for the current study in Microsoft Excel 2019. Table 1 presents the data extraction results. The factors contributing to AEs in dental practice were analysed and discussed thematically [31].

RESULTS

Study Selection

The initial database search produced 1,222 records in total. After excluding 101 duplicates, the team screened 1,121 titles and abstracts. From those, 1,008 did not meet the inclusion criteria and were removed. This left 113 full-text articles for eligibility assessment. In the end, 20 studies qualified for the final review. Figure 1 shows the process in a PRISMA flow diagram.

Study Characteristics

The studies included different designs, such as observational, retrospective, prospective and randomized controlled trials. Sample sizes went from 15 to more than 1,000 participants. Table 1 outlines the main features of each study. It covers objectives, outcome measures, reported adverse events and contributing factors.

Reported Adverse Events and Contributing Factors

The studies reported a broad array of adverse events or AEs, in dental procedures. These covered endodontic issues like root perforations, pain, nausea, vomiting, allergic reactions and procedural injuries. For example, Alghamdi *et al.* noted that almost 70% of endodontic errors involved perforations. They often stemmed from poor obturation techniques among dental trainees [32]. Brain *et al.* described drug-related AEs, including nausea and chest discomfort after analgesics [33]. In other cases of dental care, patients experienced periodontal disease and nasopharyngitis [34]. According to Brunton *et al.*, some AEs were related to dental care interventions; these included dental hypersensitivity and sensitivity to Corsodyl mouth rinse. On the other hand, some

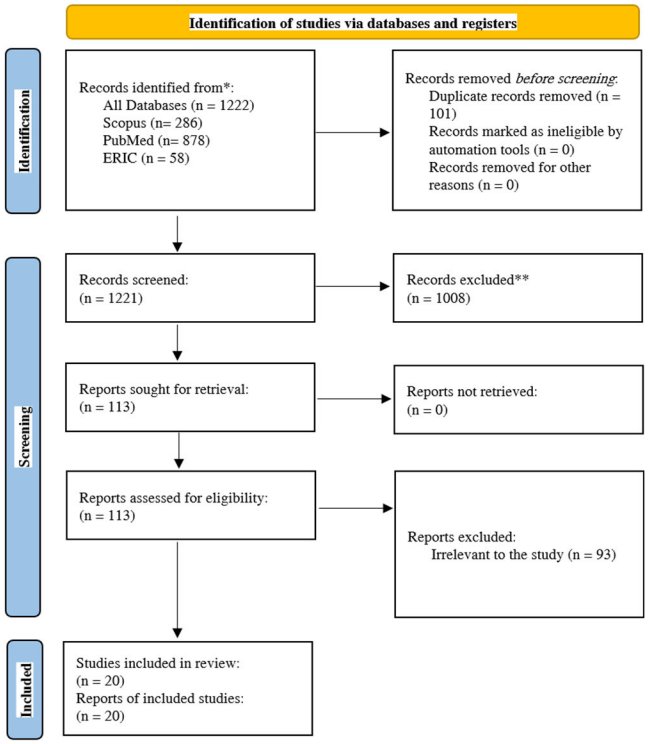

Figure 1: PRISMA flow diagram showing the study selection process

reported AEs were unrelated to the treatment; these included superficial staining, diarrhoea, vomiting, stomach upset and chest infection. Also, cases of reported rhinorrhoea, nasal congestion and discomfort, lacrimation, oropharyngeal pain, headache, procedural pain, hypoesthesia, throat irritation, paraesthesia, bradycardia, hypertension, rhinalgia, tachycardia, toothache, dysgeusia, sinus headache and upper-airway cough syndrome [35].

Furthermore, other researchers pointed to sedation complications like sleepiness, restlessness and vomiting, as seen in Davidovich *et al.* Procedural injuries also appeared, such as flap lacerations and bleeding during third molar extractions, according to de Carvalho *et al.* Issues with instrumentation were also observed. These included fractured tools or swallowed dental materials [36].

A study investigating a list of AEs reported by Mazzotti *et al.* included root fracture, inadvertent perforation of tissues, flap laceration, bleeding, soft tissue abrasion and incorrect tooth sectioning. Different dental care procedures and drugs were associated with different AEs [37].

Most included studies reported individual factors and demographics related to the procedures conducted, which contributed to the AEs [35]. In other cases, AEs were related to the drugs used [34,38]. Alghamdi *et al.* listed and correlated obturation mishaps and AEs, which were influenced by gender, teeth groups, the level of education of the practitioners and the position of the teeth [32].

Ciancio *et al.* investigated AEs for different anaesthetic options used in dental care. There were significant differences in the AEs according to the anaesthetics used

[39]. Similarly, Davidovich *et al.* and de Carvalho & do Egito Vasconcelos investigated overweight as a risk factor for AEs following dental care interventions. Both groups found that being overweight was associated with an increased probability of AEs [36,40]. Mettes *et al.* reported aging as a risk factor for AEs [41].

In addition, Hiivala *et al.* extrapolated 287 AEs, of which 63 were associated with administration of a local anaesthetic and 51 were associated with burs used in dental handpieces [38]. Mustafa *et al.* concluded that poor quality adjunctive treatment was a significant contributing factor to AEs following dental interventions and inadequate root canal filling, missed canals, overextension of root canal fillings and perforations were the major causes of AEs. Additionally, a minority of AEs were related to instrumentation and endodontics access preparation [42].

Contributing Factors

AEs were linked to instrumentation, such as manufacturing errors, poor upkeep and malfunctioning instruments or materials [21,43]. Swallowing dental instruments and inhaling dental materials were reported as contributing factors to AEs. Wu *et al.* concluded that age, sex, smoking, alcohol consumption, history of periodontitis, pain and anxiety during surgery and type and extent of surgical procedure were factors contributing to the severity of post-intervention AEs [44].

Zouaidi *et al.* hypothesized that dental sedation caused various AEs like emesis, respiratory and cardiovascular events and agitation [45].

Ozkan and Akbas compared hemodynamic responses and AEs using a fibreoptic bronchoscope. They found that nose bleeding, bradycardia, laryngospasm, hypoxia, hoarseness and throat ache occurred depending on the method of nasotracheal intubation [46].

According to Perea-Pérez *et al.*, death as an AE occurred in hospital admittance or medical treatment facilities rather than in the dental office [21].

Discussion

This systematic review provides a comprehensive overview of adverse events (AEs) in dental practice, highlighting their diverse nature and multifactorial causes. AEs in dentistry arise not only from technical errors but also from practitioner experience, patient-specific factors, procedural complexity and systemic issues such as communication breakdowns and inadequate infection control.

One of the most prominent findings was the high incidence of endodontic mishaps among dental trainees, particularly root perforations. Alghamdi *et al.* reported that nearly 70% of these complications were due to improper obturation techniques, emphasizing the need for enhanced supervision and competency-based training in dental education [32]. Therefore, it is recommended that dental schools increase faculty oversight on trainees and more rigorous assessments for dental students. Moreover, preventable AEs, such as failure to take a patient's medical history or miscommunication about allergies, can have dire outcomes, including unnecessary pain, infections and procedural complications [11]. Additionally, standardizing procedures with check lists, detailed history taking of patients before major dental procedures, emphasizing on in depth screening processes and proper collaboration with family physicians are solutions to avoid preventable AEs.

Non-preventable AEs, though less common, also pose significant risks. These include errors of commission, such as incorrect medication prescriptions or surgical mishaps, which can lead to patient morbidity or even mortality [13]. Sentinel events, such as wrong-site surgeries and anaesthesia-related fatalities, though rare, represent the most severe category of AEs. These include wrong-side extractions, ingestion or aspiration of dental materials and anaesthesia-related deaths, which have been estimated at one per 327,000 cases [14,20]. To reduce sentinel events in the dental clinic, Policymakers and accrediting bodies could develop regulations and standards for dental clinics such as the time out done in equivalent operating rooms to confirm the proper procedure and correct patient.

The implications for practice are clear; dental professionals must adopt a proactive approach to patient safety through continuous education, adherence to evidence-based protocols and improved interprofessional communication. Leadership within dental institutions plays a pivotal role in fostering a culture of safety and accountability [24]. Additionally, strict adherence to infection control measures and careful monitoring of patient conditions can significantly reduce the incidence of AEs [25]. Therefore, addressing the root causes of AEs through comprehensive strategies and continuous education is essential for enhancing patient safety and reducing the incidence of adverse outcomes in dental practice. This review underscores the need for ongoing research and policy development to better understand and mitigate the factors contributing to dental AEs.

CONCLUSIONS

This systematic review highlights the multifactorial nature of adverse events in dental practice, encompassing clinical, procedural and patient-related factors. The findings emphasize that most AEs are preventable through improved practitioner training, standardized protocols and effective communication. By categorizing AEs and identifying their contributing elements, this review offers a practical framework for enhancing patient safety in dentistry. The study's insights are particularly relevant for dental educators, clinicians and policymakers aiming to reduce harm and improve care quality. Future efforts should focus on integrating safety strategies into routine practice and supporting research that evaluates long-term outcomes of preventive interventions.

Limitations

This systematic review draws solely from existing published studies, which can restrict its insight into current clinical

practices or unreported AEs. Limiting the search to English-language articles excluded key international research, which reduces the conclusions from broader global relevance. The selected studies also differed in methodology, participant numbers and outcome assessments. These variations create heterogeneity that affects the uniformity of the overall findings.

Recommendations

Building on this review's findings, future research needs to prioritize multicenter observational studies. These would cover a wider array of clinical settings and practitioner experiences. Meta-analyses for quantitative synthesis could then create firmer statistical ties between contributing factors and particular adverse events. Additionally, newer technologies like digital error reporting systems, artificial intelligence for diagnostics and electronic health record analytics might enhance detection and prevention of AEs in the dental practice. Finally, broadening the scope to non-English literature and underrepresented regions would make future studies more relevant on a global scale.

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Ethical Statement

This study counts as a systematic review of literature published before. It did not include any direct research on human or animal subjects. All data came from publicly available sources that went through peer review. As such, ethical approval was not needed for the review.

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